

REMARKS

In the present Office Action, claims 1-4 were examined. Claims 1-4 are rejected, no claims are objected to, and no claims are allowed.

By this Amendment, claim 1 has been amended, no claims have been canceled, and new claims 5-20 have been added. Accordingly, claims 1 to 20 are presented for further examination. No new matter has been added. By this Amendment, claims 1 to 20 are believed to be in condition for allowance.

The Amendment to Claim 1 is to clarify those objections that the Examiner had relating to the amounts of the claimed ingredients, as well as limit the present claimed composition to the use of caprolactone polyol reactive diluents. New claims 7-10 claim narrower preferred compositions embodiments of the present invention. New claims 11-16 claim a process-of-use corresponding the composition of claim 1. New claims 17-20 claim a process-of-use corresponding to the narrower composition of claim 7.

The Invention

The present invention is directed to a photoimagable epoxy useful as a negative photo resist especially for applications requiring a thick film or high aspect ration of photo resist material. The compositions of the present invention include form (4) critical components: (a) at least one epoxidized poly-functional bisphenol A formaldehyde novolak resin; (b) at least one caprolactone polyol reactive diluent; (c) at least one photoacid generator; and (d) casting solvent; wherein the amounts of these four components are certain amounts or percentages.

As disclosed in the present invention, the inclusion of caprolactone polyol reactive diluents results in cured, hardened structures that are less susceptible to stress, cracking and delamination than similar compositions without the polyol reactive diluent. Examples 1-3 and Comparative Examples 1-3 on pages 10-12 of the specification specially show the improved benefits of the present invention compared to similar compositions having no caprolactone polyol reactive diluent or compositions having resin/diluent weight percentages outside the presently claimed percentage range. In particular, these Examples and comparisons show that the present claimed composition has superior "solvent-induced cracking" characteristics compared to these other compositions. Example 4 on pages 12 to 14 shows a comparison of compositions of the present invention against another

composition as to “adhesion” and “stress-induced” cracking properties. Those results again show the superiority of the present invention.

Rejections/Objections under 35 USC §112

The Examiner rejected claims 1-4 under 35 U.S.C. §112, second paragraph, as being indefinite. Specifically, the Examiner had two (2) indefiniteness objections to claims 1-4. In making these two objections, the Examiner stated the following:

“a. Claim 1 (a) and (b) components are present at about 75% to about 95% or (a) and 5% to about 25% for (b). There is never an explanation as to what makes up 100%. The examples of the specification have $(\%a) + (\%b) = 100\%$. If (a) is maximum 95% and (b) is minimum 5% there is no indication the photoacid or the optional surfactant mentioned in the specification could be part of the possible 20%, i.e. (75% a and 5% b). The examiner is unsure whether 100% is $(a) + (b)$ or 100% is the total weight of resin and reactive diluent as evidenced by adding photoacid generator by parts per hundred of resin and reactive diluent. If a different epoxy resin is added to the composition, is it limited to the 20% that is left?”

“b. In the last line of claim 1, the composition of $(a+b+c)$ is dissolved in ‘a sufficient amount of coating solvent. The examiner is unsure what sufficiency is being met by this ‘sufficient amount’. Is it coating ability? Where is the guidance for this sufficiency? Is the sufficiency directed to solubility of components (a), (b) and (c)? Is the solvent that used for (c) such as triaryl sulfonium hexafluoroantimonate salt so it can be dissolved?”

Applicant respectfully traverses this rejection by the above amendments. It is noted all of the independent claims now overcome both of these objections. No new matter is believed included or intended by these amendments.

Rejections under 35 USC §103

The Examiner rejected claim 1-4 under 35 U.S.C. §103(a) as being obvious and unpatentable over Janke et al. (US 5,726,216), alone or optionally in view of applicants’ disclosure of well known prior art on page 2 of the specifications and Schrader (US 4,474,929) and Gelorme et al. (US 4,882,245). In making this rejection, the Examiner stated the following:

“Janke et al teaches the instant composition with the exception of

specifically combining the listed epoxidized polyfunctional bisphenol A formaldehyde novolak resin more specifically SU-8, with the polyol more specifically Tone 0301, 0305 or 0310 polycaprolactone polyol reactive diluent and with the triaryl sulfonium hexafluoroantimonate salt Cyacure UV I-6974. However, Janke et al does teach as do applicants that radiation cured epoxy resins incorporating cationic photoinitiators tend to be very brittle. Schrader supports this point with respect to SU-8 in particular in his col. 1 disclosure so supports Janke et al specifically in regard to SU-8 resins. Gelorme et al in their examples also report the brittle nature of SU-8 photoresists. Gelorme addresses the problem by using other epoxies as reactive diluents to reduce the brittle nature of the SU-8 resin. In Gelorme, see particularly column 4 and examples. Janke et al are concerned with a broad group of epoxy resins including the same SU-8 epoxidized polyfunctional bisphenol A formaldehyde novolak resin which is applicant's sole concern. Janke et al's solution is broader than that of applicants in that they believe what was needed was a means by which radiation cured cationic epoxies can be toughened and still retain the good thermal and mechanical properties of the original composition. They do that by teaching the incorporation of toughening with the epoxy resin initiator mixture. These toughening agents include thermoplastics, hydroxy-containing thermoplastic oligomers, epoxy-containing thermoplastic oligomers, reactive flexibilizers, elastomers, rubbers, and mixtures thereof. An additional advantage Janke et al teach is obtained by the use of low viscosity reaction flexibilizers to reduce the overall viscosity of the uncured resin mixture. Incorporation of one or more of these toughening agents has resulted in increases in toughness of more than 230% over that of the untoughened epoxy resin according to Janke et al. Thus, with respect to instant claims 1-4, the use of any of the epoxy resins of Janke et al listed inclusive of epoxidized polyfunctional bisphenol A formaldehyde novolak resin with known photoinhibitors as listed such as the triaryl sulfonium hexafluoroantimonate salt Cyacure UV I-6974 mixed with any of the flexibilizers of Janke et al found compatible would have been prima facie obvious to obtain a less brittle cured epoxy composition. The modifying of the epoxy resin with various polyol additives such as ethylene glycol as reactive diluent is also taught separate from adding the flexibilizer. Gelorme et al in col. 4 of his disclosure does not limit his reactive diluents to epoxies. In lines 25-33, is stated 'other suitable reactive diluents will readily come to mind to those ordinary skill in resin technologies.' In Janke et al, see particularly the Abstract, col. 1, lines 15-21, col. 2, lines 35-55, col. 3, lines 40 to col. 4, lines 47, col. 5, lines 32-33, col. 6, lines 46-col. 7, lines 28, col. 8, lines,

lines 1-30, lines 62 to col. 9, lines 20 and lines 56-61, col. '10, lines 11-24, col. 14, lines 3-59. Thus, the prior art teaches adding the capropactones to epoxy resins for the same reason applicants add them to their epoxy resin compositions. The ranges of percentage of the toughener of Janke et al to epoxy resin is found in Tables 1-3 to be from 5 to 30 weight %. Thus, workers of ordinary skill in the epoxy art world would recognize that the SU-8 resins would be mixed with a flexibilizer in the same general amount to obtain a tougher cured coating as set forth by Janke et al. Applicants on page 2 of their specification make clear all but the use of the polyol with respect to the thick film resists SU-8 is known. The addition of a flexibilizer as taught by Janke et al to reduce the known brittle nature of the epoxy would have been prima facie obvious as well. The examiner does note however that Janke et al alone makes the instant composition of claim 1-4 obvious over the prior art in her opinion."

Applicant respectfully traverses this rejection for the following reasons:

Janke et al is concerned with making toughened epoxy resin/cationic initiator system comprising an epoxy resin; a cationic initiator and a toughening agent (see column 3, lines 1 and 2). The latter ingredient may be either a thermoplastic, hydroxy-containing thermoplastic oligomer, epoxy-containing thermoplastic oligomer, reactive flexibilizer, rubber, elastomer or mixtures thereof (see column 3, lines 5 to 8)., One of the epoxy resin SU-8 available from Shell (see column 5, lines 32 and 33).

The reference also states that the epoxy resin monomer may be modified by mixing with various additives. See column 6, line 46 to column 7, lists reactive diluents. Included in this long list of such additives are polyols such as glycols, aromatic diphenols and polyphenolic compounds. See column 6, lines 48 to 66.

The cationic initiator includes CYRACURE Cationic Photoinitiator UV1-6974 (see column 8, lines 27 to 29). One of the toughening agents mentioned include flexible polyol compounds also containing long aliphatic groups such as E-caprolactone triol (such as Union Carbide TONE 0301, 0305, 0310) (see column 9, lines 56 to 61).

It should be noted that Janke et al does not teach adding a separate solvent to dissolve the above-noted three ingredients or any specific suggestions for combining the four (4) presently claimed components.

In all, Janke et al. recites a vast array of possible combinations of epoxy monomers, cationic photoinitiators and toughening agents, but provides no motivation for making the particular selection of components as presently selected. Furthermore, Janke et al. or the present combination of cited references do not teach or suggest two important advantages of the present invention, namely, the better solvent-induced cracking and the adhesive characteristics. The new limitation directed to "caprolactone" polyol reactive diluents renders the Examiner's reliance of the passage of glycols and the like as polyols as less relevant.

Schrader is concerned with preparing certain epoxidized novalacs that have a more closely knit structure than the SU-8 epoxy resin (see column 2, lines 56 to 59). It appears the only specific end uses of these particular epoxidized novalacs are mentioned in short passage at column 18, lines 10 to 25. This passage does not teach the preparation of photoimagable compositions for use as negative photoresists or the mixing of such epoxidized novalacs with either a reactive polyol diluent, a cationic photoinhibitor or a casting solvent, let alone a combination of the four specific ingredients now claimed. In all, it appears the Examiner is using Schrader to confirm that SU-8 is brittle or hard when cured (see column 1, line 45 and lines 65-68). Applicants do not take issue with that fact.

Gelorme, et al. is concerned with making a photoresist composition that contains (a) an epoxyfunctional resin which is capable of being cured by the action of a cation-producing photoinitiator; (b) a reactive diluent which is soluble in developing solvents for photoresists; and (c) a cationic photoinhibitor, . . . wherein (a) comprises at least about 65% by weight of the resin solids and is dissolved in a suitable solvent; (b) comprises 10 to about 35% by weight of the resin solids; and (c) is present in an amount from about 2 to about 6 parts per 100 parts of resin and is dissolved in a suitable solvent (see column 2, lines (6 to 40). The epoxyfunctional resin can be SU-8 (see column 4, lines 5 to 7). The reactive diluent can be any reactive diluent which is effective as a plasticizer. The only specific classes of reactive diluents mentioned are cycloaliphatic epoxides (see column 4, lines 25 to 40). The photoinitiator may be a triarylsulphonium hexafluoroantimonate (see column 4, lines 62 to 67). Suitable solvents include methyl isobutyrolactone, methyl ethyl latone and mixtures thereof. It is clear that Gelorme, et al. does not teach any polyol reactive diluents, let alone polycaprolactone polyol reactive diluent.

In all, the Examiner appears to urge that it would be obvious to select the specific claimed polyfunctional bisphenol A formaldehyde novolak resin along with the specific claimed caprolactone polyol reactive diluent out of the great multitude of possible combinations of compounds mentioned in Janke et al. However, the Examiner never provides any reason why it would be obvious to select these particular classes of compounds and then combine them. Janke et al. or the other references certainly offers no reason to do so. It thus appears that the Examiner is attempting improper hindsight or obvious-to-try reasoning by this rejection.

The Examiner also rejected claims 1-4 under 35 U.S.C. 103(a) as being obvious and unpatentable over Gelorme et al. (US 4,882,245), taken in view of Janke et al. (US 5,726,216). In making this rejection, the Examiner stated the following:

“Gelorme et al teach the instant composition with the exception of the polyol being used to reduce the brittle nature of the epoxidized polyfunctional bisphenol A formaldehyde novolak resin more specifically SU-8 resin. Gelorme et al addresses the same problem with the addition of 12 to 17 wt % of (b) a reactive diluent also effective as a plasticizer. The actual ones used by Gelorme et al are all epoxy compounds. Gelorme et al in col. 4 of his disclosure does not limit his reactive diluents to epoxies. In lines 25-33, is stated “other suitable reactive diluents will readily come to mind to those ordinary skill in resin technologies.” Such reactive diluents other than epoxies are known in the resin technologies as set forth by Janke et al. The modifying of the epoxy resin with various polyol additives such as ethylene glycol as reactive diluent is also taught separate from adding the flexibilizer his polycaprolactone flexibilizer. In col. 9, lines 17-20, Janke et al states hydroxy groups are reactive with epoxies and in the paragraph bridging col. 6-8, Janke et al sets forth such known reactive diluents. Thus, with respect to instant claims 1-3, the use of the polyols of col. 6 of Janke et al as (b) components in Gelorme et al would have been prima facie obvious. With respect to instant claim 4, the use of the flexibilizer of Janke et al, to toughen the compositions of Gelorme et al would also have been an obvious variant to reduce the brittle nature of the SU-8 resists. In Janke et al, see particularly the Abstract, col. 1, lines 15-21, col. 2, lines 35-55, col. 3, lines 40 to col. 4, lines 47, col. 5, lines 32-33, col. 6, lines 46-col. 7, lines 28, col. 8, lines 1-30, lines 62 to col. 9, lines 20 and lines 56-61, col. 10, lines 11-24, col. 14, lines 30-59. Janke et al’s solution is broader than that of applicants in that they believe what was needed was a means by which radiation cured cationic epoxies can be toughened and still retain the good thermal and mechanical properties of the original

composition. They do that by teaching the incorporation of toughening with the epoxy resin initiator mixture. These toughening agents include thermoplastics, hydroxyl-containing thermoplastic oligomers, epoxy-containing thermoplastic oligomers, reactive flexibilizer, elastomers, rubbers, and mixtures thereof. An additional advantage Janke et al teach is obtained by the use of low viscosity reactive flexibilizers to reduce the overall viscosity of the uncured resin mixture. Incorporation of one or more of these toughening agents has resulted in increases in toughness of more than 230% over that of the untoughened epoxy resin according to Janke et al.”

Applicant respectfully traverses this rejection for the following reasons:

The inserted limitation of “caprolactone” polyol reactive diluents is believed to overcome this rejection. It is noted that Janke et al. never referred to caprolactone polyols as reactive diluents, but instead referred to them as a species of toughening agents. Accordingly, the substitution of them for the reactive diluents mentioned in Gelorme et al. is unwarranted. Again, there are a vast number of different polyols and neither reference teaches or suggests the selection of caprolactone polyols out of this vast array would have any particular benefit to a polyfunctional bisphenol A formaldehyde novolak-type resist. It is improper for the Examiner to use hindsight or the obvious-to-try theory to make this rejection.

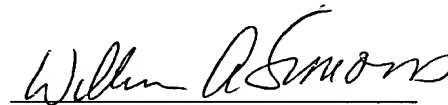
The prior art made of record and not relied upon is considered pertinent to applicant’s disclosure. Day et al. (U.S. Patent No. 5,278,010) cited by applicants discloses polyols (PKHC as a phenoxy polyol resin) mixed with SU-8 epoxy resins. The weight ratios do not fit those of the instant invention nor does the examiner believe that the worker of ordinary skill in the art would consider the solid PKHC resin to be classified as a diluent since dilution is usually considered to be limited the addition of liquid.

Accordingly, Applicant submits that none of the references, alone or in combination, anticipate or make obvious the invention as presently claimed and that the application is now in condition for allowance. Therefore, Applicant respectfully requests reconsideration and further examination of the application and the Examiner is respectfully requested to take such proper actions so that a patent will issue herefrom as soon as possible.

If the Examiner has any questions or believes that a discussion with Applicant's attorney would expedite prosecution, the Examiner is invited and encouraged to contact the undersigned at the telephone number below.

Please apply any credits or charge any deficiencies to our Deposit Account No. 23-1665.

Respectfully submitted,
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